Interagency Ecological Studies Program for the Sacramento-San Joaquin Estuary

NEWSLETTER

Autumn 1993

Readers are encouraged to submit brief articles or ideas for articles. Correspondence, including requests for changes in the mailing list, should be addressed to Randy Brown, California Department of Water Resources, 3251 S Street, Sacramento, CA 95816-7017.

The Peripheral Canal: What We Need to Do Before We Start Building

Wim Kimmerer
BioSystems Analysis Inc.

> **Editor's Note**: This article is the result of several discussions I have had with Wim Kimmerer regarding the potential benefits of a peripheral canal-type facility. I asked Wim to put his thoughts on paper with the goal of stimulating discussion on this important topic. Anyone wishing to respond to Wim's ideas in the next Newsletter, should send written comments to me by mid-December. (R. Brown, DWR)

I have heard, with increasing frequency: *"The delta is broke, and we have to fix it."* The belief of many people involved in bay/delta issues, including biologists, is that a peripheral canal or other facility would improve conditions in the delta for fish and other organisms. In this article, I discuss what we know about the delta, why I believe our knowledge is inadequate to support or reject construction of such facilities, and what we need to do to fill the gaps.

This note is intended to be provocative, and I hope it will stimulate useful, informed discussion. It neither supports nor opposes construction of a peripheral canal, but rather suggests that more information is needed. We have learned a great deal since the peripheral canal idea was last seriously examined, and some of this knowledge calls the underlying assumptions of such a canal into question.

Assumptions:

- The purpose of the facility is to improve conditions for fish in the estuary while maintaining water exports.
- Provisions for constructing the facility would include a regulatory guarantee of estuary protection.

Stipulations:
(ie, things most of us would agree to)

- Many bay/delta species are in a state of decline, and freshwater flow has something to do with many of these declines.
- A peripheral canal or similar facility would require a huge, irretrievable allocation of capital and could impose a significant burden on those who have to pay (taxpayers, rate payers, or consumers — us).
- Opinions in this article are mine.

The underlying problem is clear: a mismatch in time and place between water supply and demand. Increasing human populations in California will ensure that this problem can only worsen. Declining populations of bay/delta fish and other species will ensure increased regulatory attention by resource agencies. We are seeing

CONTENTS

The Peripheral Canal: What We Need to Do Before We Start Building 1
New Regional Monitoring Program for Toxins 4
San Francisco Estuarine Institute Created from Aquatic Habitat Institute 5
New Developments in Fish Facilities 6
Clifton Court Forebay Predator/Predation Control 8
Delta Smelt 9
Diazinon Concentrations in the Sacramento and San Joaquin Rivers and San Francisco Bay 10
Delta Flows 12
Directors Tour Estuary 12
Georgiana Slough Acoustical Barrier 13
GIS Workshop 13
Available from Aquatic Habitat Institute 13

the beginnings of this in the form of actions under the Endangered Species Act and Clean Water Act.

Solutions to the problem of declining fisheries have been offered in several forms, most of them expensive. Increased freshwater flow, whether by pulse flows or well-timed increases, has been offered as one way to improve conditions in the delta, but it does not address increasing demand. A peripheral canal offers a way out of this dilemma, but only if the problems in the bay and delta are caused by entrainment.

The idea that entrainment of fish is the sole important issue in the delta has become an article of faith among some biologists and is one reason for this note. I think this belief arises from an erroneous conceptual model of delta hydrodynamics and historical emphasis on species for which there is evidence that entrainment is a major problem.

Delta Hydrodynamics

Many biologists view the delta as a riverine system. I hear talk of reverse flows in the lower San Joaquin River and of salmon and other fish being transported from the Sacramento River to the lower San Joaquin and sucked upstream to the pumps. However, most of the delta is a tidal environment in which small net flows are superimposed on huge tidal flows. Net flows in delta channels are determined by calculation and should be viewed as indices rather than actual flows.

The calculated reverse flow at Jersey Point, if accurate, implies a velocity no more than a few percent of the tidal flow, and a net displacement of only about 1 kilometer over a complete tidal cycle. Dispersion resulting from interaction of the tides with the complex geometry of the delta should be seen as the principal mechanism for transport of particles in this region.

A similar situation exists at Chipps Island in summer. Net delta outflow is of a similar magnitude to export pumping, yet most of the salt balance in the estuary is mediated by dispersion rather than advection. In other words, net outflow sets the longitudinal position at which salt water and fresh water mix, but dispersion has a greater influence on the movement of salt up and down the estuary. The situation for particles, especially living ones, is more complex, but particles that sink or swim downward are affected only by stratification, tidal mixing, and the longitudinal density gradient — not directly by outflow.

The new particle-tracking models should help us understand how the delta actually "works". It is important for biologists to study and understand the results of these models and to revise their conceptual models accordingly. However, we should be wary of all of these models until they have been tested against field data on the property of interest: movement of particles and substances other than salt.

Effect of Flows on Biota

Several species in the estuary respond positively to increased delta outflow, either in their abundance or in survival. Outflow is inversely related to export flow and directly related to several other variables such as X_2 (position of 2 ppt salinity) and entrapment zone position. Therefore, it is difficult or impossible to determine causal mechanisms using statistical methods.

Several species (longfin smelt, for one) do not go far enough upstream for entrainment to have much effect; thus, these species are clearly affected by outflow or its correlates. For *Neomysis*, which does go upstream, I have calculated that entrainment losses to the population are negligible. Although not everybody agrees with this analysis, so far no alternative has been presented, and I conclude that *Neomysis* responds directly to outflow or a covariant other than entrainment. Similar calculations have shown no effect of entrainment on other populations important in the food chain.

Much of the concern over the direct effects of entrainment come from the observation that a lot of fish are collected at the fish facilities. However, it is difficult to put these in context without information on the size of affected populations and the rates of survival that would exist without entrainment losses.

DFG's striped bass model shows significant effects of entrainment. This model has been criticized as statistically weak — not a trivial criticism, since the model is mostly empirical. There is reason to believe exposure to entrainment of at least the part of the population spawning in the San Joaquin River can cause significant mortality. However, this belief is based more on knowledge of the spawning habitat and biology of bass than on analysis of data or models.

Emphasis for protection of estuarine species has shifted away from striped bass toward special-status species such as delta smelt and winter-run Chinook salmon. More species can be expected to join this list in the near future, and protection of these species will drive decisions about estuarine protection. However, we do not know much about the biology of these species or how they are affected by flows. It would be a mistake to assume what is good for striped bass is good for all species.

Information on survival of winter-run salmon is based on the USFWS model of fall-run smolt passage and on data on timing, distribution, and salvage of fish presumed by their size to be winter-run. However, we do not really know how the survival of winter-run salmon depends on exports. Furthermore, completely eliminating mortality of winter-run salmon passing through the delta during the last 2 decades would have resulted in a relatively small increase in subsequent escapement over historical values and would not have prevented the decline.

What Needs to be Done?

If we understood the delta much better than we do now, we would be in a better position to make an informed decision about building new facilities. It is always nice to know more than we do, and demands by scientists for more research can be seen (often correctly) as self-serving. However, the research effort outlined here would be small compared to costs of constructing and maintaining a peripheral canal. I think that in the next 3 to 5 years we can learn enough to make this critical decision — and be right about it.

The first thing we need to know better is the hydrodynamics of the delta. Significant progress is now being made. First, particle-tracking models are beginning to show how different flow patterns affect the movement of passive particles. Second, direct measurements are being made of net flows in delta channels, which will permit partial validation of the hydrodynamic models being used for particle tracking. Third, development of 3-dimensional models, along with a substantial research program on hydrodynamics of the entrapment zone, will improve knowledge of the coupling between the freshwater region of the delta and the estuarine regions downstream.

It is essential that this advance in hydrodynamics be combined with research on biology. This should complement and provide specific feedback to the groups working on hydrodynamics. I believe the work of the hydrodynamics groups should be determined to a large extent by the needs of biologists to understand the ecosystem. To date, except for the particle-tracking models, this has not happened.

The following questions (in no particular order) need to be answered before an informed decision can be made about delta facilities.

- How accurately do the particle-tracking models represent the movement of inert particles and organisms in the delta and Suisun Bay?
- What are the relative roles of longitudinal advection, dispersion, gravitational circulation, and lateral circulation in the maintenance of populations and in larval recruitment of fish and invertebrates?
- How does the behavior of Chinook salmon and juvenile striped bass affect their distribution, passage, and survival through the delta?
- How do the negative buoyancy of striped bass eggs and vertical positioning behavior of larvae affect their passage through the delta?
- What are the population-level implications of changes in survival of life stages vulnerable to entrainment?
- To what extent do water withdrawals within the delta affect species there?
- What are the mechanisms causing variation with delta outflow or X_2 in the abundance of *Neomysis*, *Crangon franciscorum*, longfin smelt, and starry flounder?
- To what extent are observed covariations with flow direct, and to what extent indirect (*eg,* through toxicants or the food chain)?
- Does flow affect delta smelt and splittail and, if so, how?

These questions can be answered through appropriate combinations of field research and modeling. We need new conceptual models and population models for the estuary that can be coupled with the developing hydrodynamic models to try to predict what will happen if the delta plumbing is changed.

Conclusions

A peripheral canal or similar facility might provide significant benefits to some species. However, the benefits of a peripheral canal to many species are unknown. Important questions need to be answered about how the hydrodynamics of the delta, and abundances of estuarine populations, might change with construction of a peripheral canal. Given the enormous, irretrievable cost of a peripheral canal, spending a few million dollars on a focused research program does not seem like a waste of money.

For those biologists and agency managers who would prefer to skip the research and go straight to construction, I pose this question:

If a peripheral canal were built now and the problems did not go away, what would you tell your colleagues, and how should your agency explain your mistake to the public?

New Regional Monitoring Program for Toxins

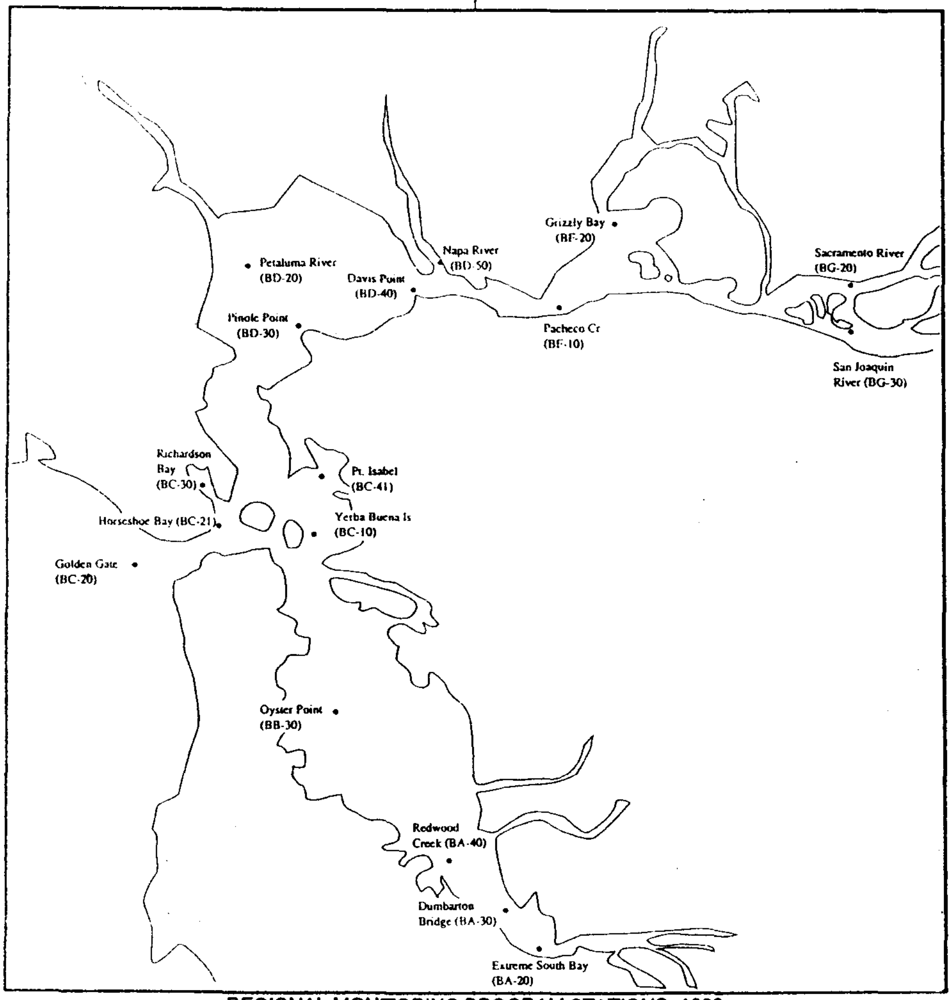
Bruce Thompson and Margaret Johnston
Aquatic Habitat Institute

In 1991, the San Francisco Bay Regional Water Quality Control Board began pilot monitoring under the State's Bay Protection and Toxic Clean-up Program and other programs. In 1992, the Regional Board, Aquatic Habitat Institute, and estuary dischargers began planning a permanent San Francisco Estuary Regional Monitoring Program based on results of the pilot studies. In January 1993, Applied Marine Sciences of Livermore (Drs. Bob Spies and Andy Gunther) assembled an outstanding team of scientists and were selected as contractors for the RMP.

The first year RMP is sponsored by 42 agencies and companies contributing $1.15 million. Decisions about the program are made by a Technical Program Review Committee and a Policy and Steering Committee. The main purpose of the RMP is to provide information the Regional Board can use to evaluate the effectiveness of its water quality program in protecting beneficial uses of the estuary.

This first year has focused on contaminants in water, sediment, and tissues of transplanted bivalves and water and sediment toxicity testing. Sampling is conducted at 16 stations throughout the bay (see map, below). Field sampling and logistics are handled by Dane Hardin of Marine Research Specialists in Aptos. They use the research vessel *David Johnston* (USGS/UCSC) for sediment and water sampling, and vessels from the City of San Francisco (*Rincon Point*) and East Bay Municipal Utility District (*Bay Monitor*) for bivalve deployment, maintenance, and retrieval.

Water is sampled three times a year during wet, dry, and declining hydrograph periods, plus stations on the Sacramento River (Rio Vista) and San Joaquin River (Manteca) are sampled over a 6-week period during peak flow. Samples are pumped from one meter below the surface using ultraclean methods. The table below shows contaminants measured.



REGIONAL MONITORING PROGRAM STATIONS, 1993

TRACE METALS AND ORGANIC CONTAMINANTS ANALYZED IN THE REGIONAL MONITORING PROGRAM

Petroleum Compounds
- Alkanes, n-C12 to n-C32
- Phytane
- Total saturated and aromatic petroleum hydrocarbons

PAHs
- Anthracene
- Fluoranthene
- Pyrene
- Benza(a)anthracene
- Chrysene
- Benzo(b)fluoranthene
- Benzo(k)fluoranthene
- Benzo(e)pyrene
- Benzo(a)pyrene
- Indo(1,2,3-c,d)pyrene
- Dibenzo(a,h)anthracene
- Benzo(g,h,i)perylene
- 1-methylphenanthrene
- Total methyphenanthrenes

Trace Metals
- Arsenic
- Cadmium
- Chromium
- Copper
- Cyanide
- Lead
- Mercury
- Nickel
- Seleneum
- Silver
- Tributyltin (tissue only)
- Zinc

Synthetic Biocides
- Hexaclorocyclohexanes
- Chordanes (including heptachlor epoxide)
- DDTs
- Endosulfan (water only)
- Dieldrin
- Chloropyriferos (water only)
- Dacthal (water only)

Synthetic Compounds other than Biocides
- Hexaclorabenzene
- Polychlorinated terphenyls
- PCBs, total and selected congeners

Dr. Russ Flegal (UC-Santa Cruz) and Brooks-Rand of Seattle are analyzing trace metals, and Dr. Bob Risebrough (UCSC) is analyzing trace organics. Salinity, nutrients, dissolved organic carbon, chlorophyll, dissolved oxygen, temperature, suspended solids, and pH are also measured. Dr. S.R. Hansen of Concord is testing water toxicity, using a *Thalassiosira* (diatom) test and a larval mussel test.

Sediments are sampled in the wet and dry seasons, using a modified Van Veen grab. Similar contaminants are measured in sediment as in water. Sediment grain size, total organic carbon, redox potential are also measured. Sediment toxicity testing is conducted by Mr. John Hunt at the UCSC Granite Canyon Laboratory using an *Eohaustorius* (amphipod) test and a larval mussel test using sediment elutriates.

Bagged, transplanted mussels, oysters, and clams are deployed for 90 days during wet and dry season sampling. Their tissues are analyzed for bioaccumulation of the same contaminants as measured in water.

This year, a pilot study on hydrography and water quality is being conducted by Dr. Jim Cloern (USGS) and Dr. Alan Jassby (UC-Davis). They are collecting monthly data on water column structure and bimonthly data on the phytoplankton community and production. Their study will help determine how to incorporate such measurements into the RMP.

Next year several new stations, pilot studies on fish tissue contamination and benthic macrofauna, and laboratory intercalibration exercises will be added to the program. Special studies on sampling design, ecological indicator development, and sediment transport will also included.

The RMP is scheduled to continue to grow over the next few years. Each year the program will be reviewed and improved to achieve an optimal design that provides sound answers to questions about contaminant concentrations, their trends, and ecological effects in the estuary.

San Francisco Estuarine Institute Created from Aquatic Habitat Institute

Recognizing a need for comprehensive monitoring and research to assess the chemical, biological, and physical health of the estuary, the Aquatic Habitat Institute Board of Directors has proposed creating from AHI a new organization. The mission of the new "San Francisco Estuarine Institute" will be: *To provide the scientific understanding needed to manage competing uses of the complex and biologically rich San Francisco Bay / Delta Estuary.*

Fulfilling this mission will require that SFEI build upon existing programs and work with all those making decisions for the estuary — federal, state, and local agencies; research institutes; academic institutions; nonprofit and private interests — to ensure that priority issues are addressed and services are not duplicated. SFEI will supplement and enhance existing programs with new monitoring elements and research studies. It will create a forum in which monitoring and research priorities can be established and a central point at which information can be made accessible.

SFEI will be structured to ensure balance between policy and science. The Board of Directors is being selected so as to provide public and private organizations with substantial interest in management of the estuary. Board members will be policy makers from government, academia, business, and public interest groups. Two working panels will advise the Board — a Scientific Panel and a Policy Panel. The small SFEI staff will be an interdisciplinary team of scientists, data analysts, and project managers and will consist of permanent positions, post-doctoral research fellowships, and tempory assignments from agencies with ongoing monitoring and research programs related to the work of SFEI.

Implementation of the comprehensive program is expected to cost about $10 million annually. As much as 80 percent of the money might be used as grants and contracts for research, monitoring, data management, and communications. The rest will support staff research and analysis, coordination among agencies, and administration of contracts. Funding is expected to come from new or re-directed appropriations of federal, state, and local monitoring and research efforts, fees assessed against those whose activities modify the estuary (*eg*, discharge of treated waste, storm water, and agricultural drainage; diversion of water; and dredging and disposal of dredged material), and traditional sources such as foundations and industrial associations.

Although legislation is not required to found the SFEI, the AHI Board of Directors believes recognition of its mission and establishment of long-range funding sources are desirable. The transition to the SFEI is expected by the end of the year.

New Developments in Fish Facilities

Darryl Hayes
DWR, Environmental Services Office

Two developments related to fish protective facilities that are under investigation by the hydroelectric industry may apply directly to projects in the delta. Both systems are variations of or modifications to traditional designs, and both are versatile and potentially cost effective at improving many fishery-related problems. The designs and their potential applications are discussed here.

Modular Inclined Screen

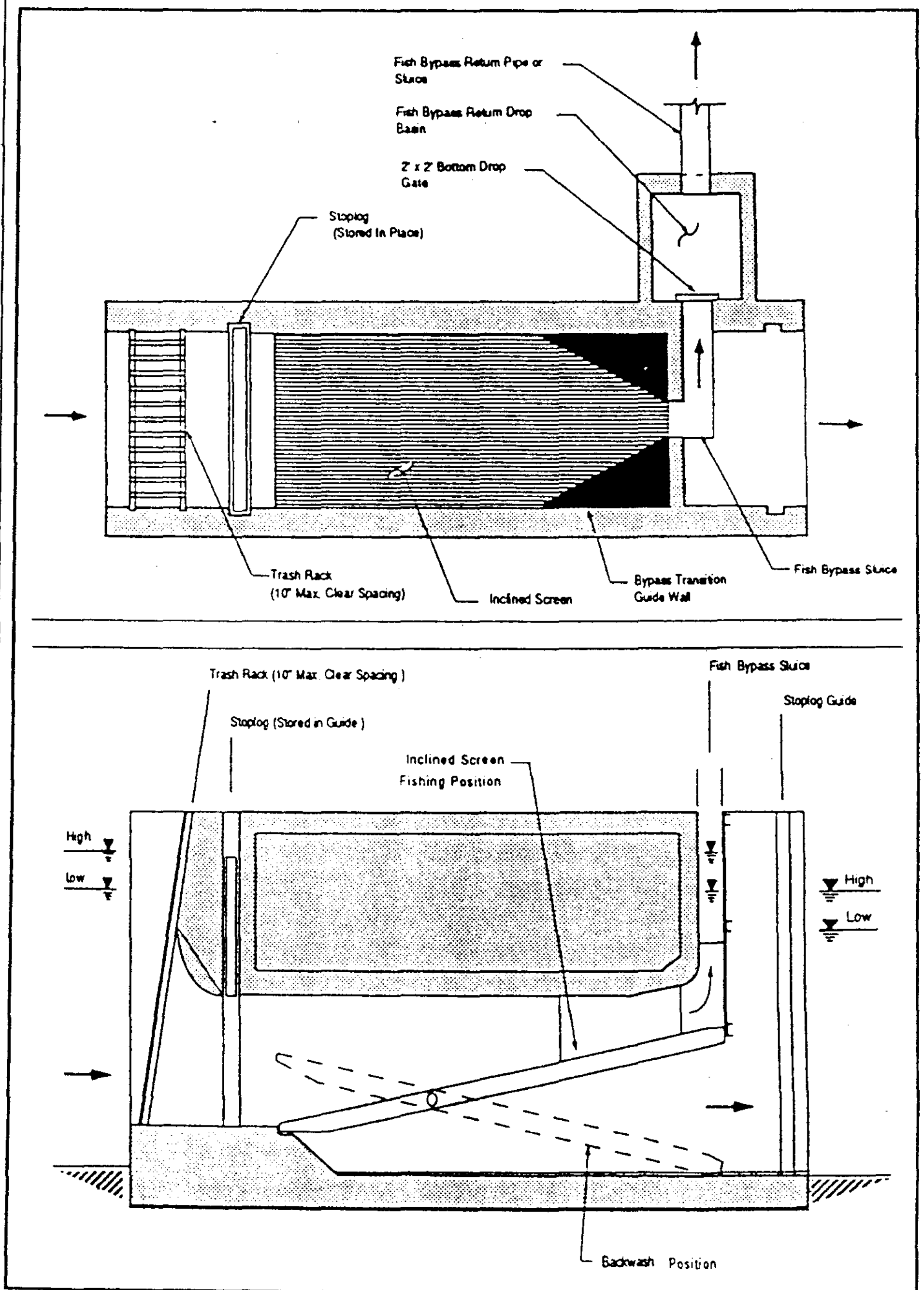
Electric Power Research Institute has been developing a Modular Inclined Screen — a high-velocity fish screen that shows promise for protecting a wide range of fish species. The screen is similar to the Eicher penstock screen, but with a "modular" design, improved hydraulic characteristics, and application to a broad range of water intakes. Unlike the penstock screen, this screen can be placed in canals, forebays, or pumping plant intakes.

The MIS consists of a fully submerged, rectangular culvert with a trashrack over the entrance; dewatering stoplogs; an inclined wedgewire screen set at a shallow angle of 15 degrees to the flow; and a bypass for diverting fish into a transport pipe (see plan and section view, at right). The screen is mounted on a pivot shaft so it can be cleaned via rotation and backflushing. Depending on fish species and life stages to be protected, the module can operate at water velocities from 2 to 10 feet per second.

Due to a standardized design size (screens about 10 feet wide by 30 feet long), additional modules can be placed side by side to achieve desired approach velocities. This design may have several advantages over traditional screening systems:

- It can operate over a range of fluctuating water levels and flow conditions.
- Fish are exposed to the screen for only a short time.
- Each module can be dewatered easily.
- Because it is compact, cost savings would be significant.

Biological studies are being conducted in a 1:3.33-scaled prototype at Alden Research Laboratory in Holden, Massachusetts. Passage survival above 95 percent was achieved over a range of velocities (2-10 fps) with juvenile (45-170 mm) Chinook, coho, and Atlantic salmon. Other species tested, with similar results, include bluegill, walleye, rainbow trout fry, catfish, and alosid juveniles. In fall 1994, a



PLAN AND SECTION VIEW OF THE MODULAR INCLINED SCREEN single 1:1.7-scaled unit will be tested in the Hudson River in New York. (DWR will provide some funding for this effort.) Additional field studies with delta species will be necessary before the design is acceptable to state and federal regulatory agencies.

Floating Louver Fish Guidance System

Northwest Utilities Service Company recently evaluated a floating louver fish guidance system on a large (3,000 cfs) channel off the Connecticut River to exclude Atlantic salmon smolts and anadromous clupeids from a hydroelectric turbine intake. Louvers have been effective in diverting many fish species in various situations, but they cannot effectively reduce entrainment of small fry or larvae (<20 mm) and are not considered appropriate for many applications.

In louver systems, vertical slats are placed in a diagonal line at a shallow angle to the flow and across the path of down-migrating fish. The slats are placed at right angles to the flow and create a turbulence, which fish tend to avoid. Because fish are not physically excluded from passing through the barrier, louver systems are considered behavioral barriers.

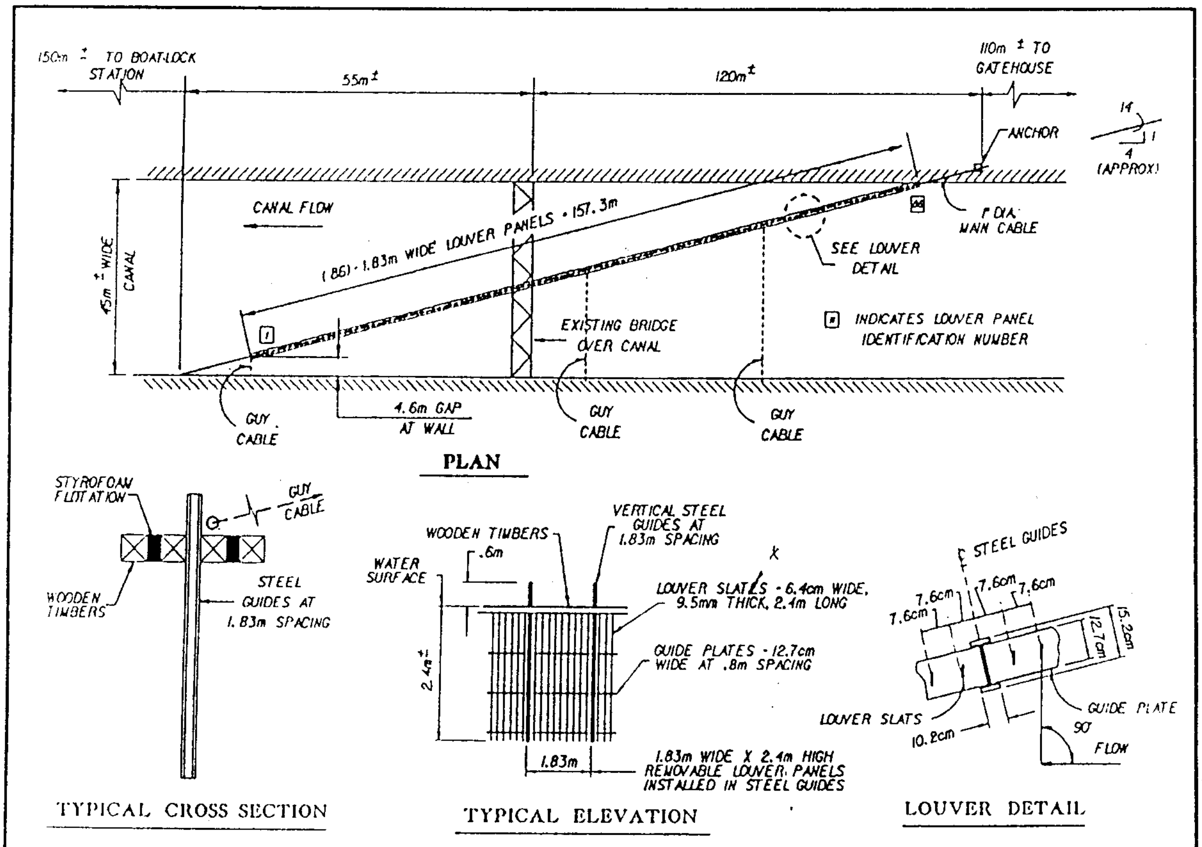
Costs and physical limitations of screening an entire channel to divert fish into a bypass pipe or alternative diversion have prohibited the use of many such systems. The floating louvers would screen only the surface flow; the concept is based on the fact that salmon smolts and anadromous clupeids tend to migrate near the water surface.

To determine whether a partial-depth system would be as effective as a full-depth one, a floating platform with suspended louver panels was installed adjacent to a hydroelectric plant near Holyoke, Massachusetts. Design details are shown below. Biological evaluations have had 50 to 100 percent guidance efficiencies (87 percent mean) with Atlantic salmon smolts (about 120 mm TL) over a range of depths from 1.2 to 2.4 meters.

The floating systems proved to be structurally rugged and were able to withstand debris loads as long as they were removed for cleaning periodically. The installed cost of this temporary system was about $150 per linear foot.

A louver fish guidance system installed, for example, near the head of Steamboat, Sutter, or Georgiana slough on the Sacramento River might keep a higher percentage of salmon smolts out of the central delta and improve their chances for survival. Additional research is needed to determine the minimum effective depth of submergence and maximum acceptable slat spacing for target species and life stages.

For additional information, contact Darryl Hayes at 916/327-8414.



DESIGN DETAILS OF THE HOLYOKE FLOATING LOUVER

Clifton Court Forebay Predator/Predation Control

Patrick Coulston
DFG Bay-Delta and Special Water Projects Division

Clifton Court Forebay is a shallow, 2,200-acre reservoir just upstream of the SWP's Banks Pumping Plant and Skinner Fish Facility. Water to be exported from the delta enters the forebay through a set of tidally-operated radial gates on Old River. The radial gates are generally opened around high tide, when the water level in Old River is higher than in the forebay. Forebay operation reduces the impact of SWP export pumping on water levels in the southern delta.

Fish entrained into Clifton Court Forebay must swim about 2.5 miles across the forebay before reaching the fish facility, where they can be salvaged and returned to the central delta. Loss of entrained fish before they reach the fish facility is commonly called "pre-screen" loss.

Since the late 1970s DFG (with DWR funding), has been studying the extent and causes of pre-screen fish loss. Although much remains to be learned about the dynamics of pre-screen loss rate, the evidence suggests pre-screen losses of juvenile striped bass and salmon can be high and that they are primarily the result of predation by other fish. The main predators seem to be sub-adult striped bass, although white catfish, channel catfish, largemouth bass, and several other predators are also present.

Estimates of pre-screen loss are used in a couple of important ways. For example:

- They are used to calculate of the number of salmon, steelhead, and striped bass lost each year at the SWP export facilities, which in turn is the basis for the amount of funds DWR provides each year to mitigate export losses.
- They are used to calculate take limits established by the National Marine Fisheries Service's biological opinion relating to the effects of SWP and CVP operations on winter-run Chinook salmon.

Under the guidance of the IESP Fish Facilities Technical Committee, DFG's Bay-Delta Division has been looking for ways to reduce pre-screen loss rates by removing and relocating predators. During fall 1991, several capture methods were tried, including large fyke-traps, gill-nets, a 2,000-foot seine, and hook-and-line angling. (It was during this effort that a 49-pound alligator gar was captured [reported in the September 1991 *Newsletter*].) The 1991 work indicated large numbers of predators could be captured in good condition using large-scale seining methods.

In March 1992, during a 3-week pilot predator removal effort, about 1,500 adult and sub-adult striped bass and 500 other predators were captured and released into the delta. Although methods used were crude, the effort did show large predators could be captured and transported alive to the central delta. Population estimates associated with this effort indicated about 150,000 adult and sub-adult striped bass inhabited the forebay.

From November 1992 through March 1993, a sustained predator removal effort was attempted using DFG staff and a contracted commercial fisherman operating a 600-foot Kodiac-type trawl. The goal was to determine if the number of adult and sub-adult striped bass could be measurably reduced, with a corresponding reduction in pre-screen loss rate. More than 32,000 predators, including almost 29,000 striped bass, were removed from the forebay, but in April the striped bass population was estimated at about 200,000. Apparently the striped bass population in the forebay is quite dynamic, and controlling it will require substantial effort.

Some interesting observations were made about the fish community in the forebay. Among the fish captured last winter were 38 green sturgeon (up to 1850 mm FL) and 136 white sturgeon (up to 1646 mm FL). Also captured were 17 adult salmon that apparently had strayed into the forebay during spawning migration.

In preparation for an August workshop, DFG solicited ideas on how predators should be controlled. Some suggestions were:

- Increase recreational fishing pressure by allowing fishing boats on the water and providing rewards for captured predators.
- Build a narrow corridor of netting material between the forebay radial gates and the outlet channel to separate entrained fish from predators.
- Lower forebay water levels to improve efficiency of removal efforts.
- Concentrate predators through chumming, lights, sound, *etc.*
- Remove "snags" from the forebay to facilitate netting efforts.

The Bay-Delta Division drafted a predator removal plan for discussion at the August 3 workshop, which was part of planning called for by DFG and DWR management to attempt a large-scale predator removal effort beginning this fall. The goal is to remove 150,000 predators from the forebay between September 1993 and April 1994. Major elements of the proposal were:

- Open the forebay year-round to public fishing by boat.

- From September 1 through mid-October, allow recreational anglers to keep captured predators without regard to normal size and creel limits.
- From mid-October through early December, conduct an intensive removal effort involving state personnel and contracted commercial fishermen, forebay drawdowns, and several tank trucks.
- Reduce intensity of removal efforts to a single commercial seiner from mid-December 1993 through March 1994.
- Truck captured predators downstream of Chipps Island and release them.
- Evaluate the effectiveness of the effort through population estimates in December 1993 and March 1994 and predation rate experiments in early December 1993 and April 1994.

About 40 people attended the workshop in August to identify and resolve regulatory, biological, and logistical issues associated with large-scale removal and relocation of predatory fish from Clifton Court Forebay. Those attending represented water development, fishery, and regulatory agencies as well as the fishing public. Terry Tillman (DFG) and his staff organized the workshop.

The workshop began with a summary of information from previous research on predators (composition, abundance, food habits) and predation and a presentation of the draft proposal. The afternoon was devoted to vigorous discussion of predator control and specifics of the proposal. Some major points were:

- Unless DWR and NMFS agree on a reduction in the assumed rate of winter-run salmon prescreen loss prior to the removal effort, the removal effort (if successful) would result in a perceived increase in winter-run "take" by the SWP through increased salvage. This could lead to increased constraints on SWP exports associated with the NMFS take limits.
- Some form of environmental documentation will probably be required for the project.
- Predators, especially striped bass, should be released farther downstream than Chipps Island to avoid increasing in-delta predation on winter-run salmon and delta smelt.

Representatives of the fishing public condemned the proposal for two reasons.

- The striped bass population could be harmed by increased exploitation associated with the proposed no-limits fishing in early fall and incidental mortality associated with the netting and removal efforts.
- Reduction in entrainment losses would allow greater pumping by the SWP, which in turn would result in even greater indirect losses.

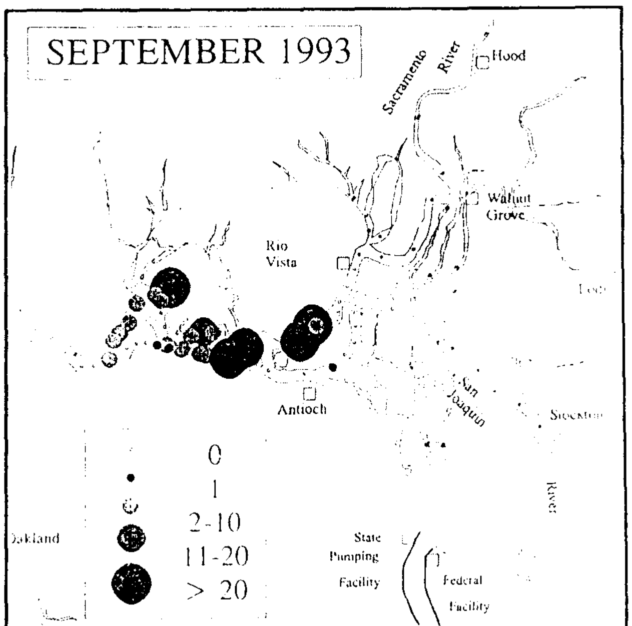
Because of the number and types of issues raised at the workshop, major predator removal this fall would not be practical. Workshop findings are being summarized for distribution to interested parties, and the Bay-Delta Division is looking for ways to resolve major issues in time for predator control in fall 1994.

Delta Smelt

DWR recently completed a biological assessment on impacts of CVP and SWP operations on the threatened delta smelt. Transmittal of this document from USBR to USFWS will be used to initiate formal consultation under Section 7 of the Endangered Species Act. It now appears that the biological opinion expected next February will be for one year rather than long term. It will replace the one-year opinion released by USFWS in late May 1993. Call Mary (916/323-7203) for a copy of the assessment.

Results of the fall midwater trawl survey yielded a September delta smelt index of 375, the third highest on record. The fall index is the sum of the individual indices for September through December. We hope the next three months will continue to show high abundance.

The delta smelt in the September survey were concentrated in the lower Sacramento River and Suisun Bay (see figure at right). In spite of relatively low streamflows and high pumping, few smelt had moved into the lower San Joaquin River.



DISTRIBUTION OF DELTA SMELT, SEPTEMBER 1993 MIDWATER TRAWL SURVEY

Diazinon Concentrations in the Sacramento and San Joaquin Rivers and San Francisco Bay

Kathryn M. Kuivila, USGS

The effects on aquatic biology of dormant spray pesticides used on orchards in the Central Valley are an environmental concern (Foe and Connor 1991), but little is known about pesticide sources and transport in the river/estuary system. This report describes dissolved concentrations and movement of diazinon, a major dormant spray pesticide, through the Sacramento-San Joaquin Delta and the adjacent part of San Francisco Bay during February 1993. This study was done in cooperation with the California Regional Water Quality Control Board, Central Valley Region, and is part of the USGS San Francisco Bay-Estuary Toxic Contaminants Study of sources, transport, and fate of pesticides in the river/estuary system. The study area is shown in Figure 1.

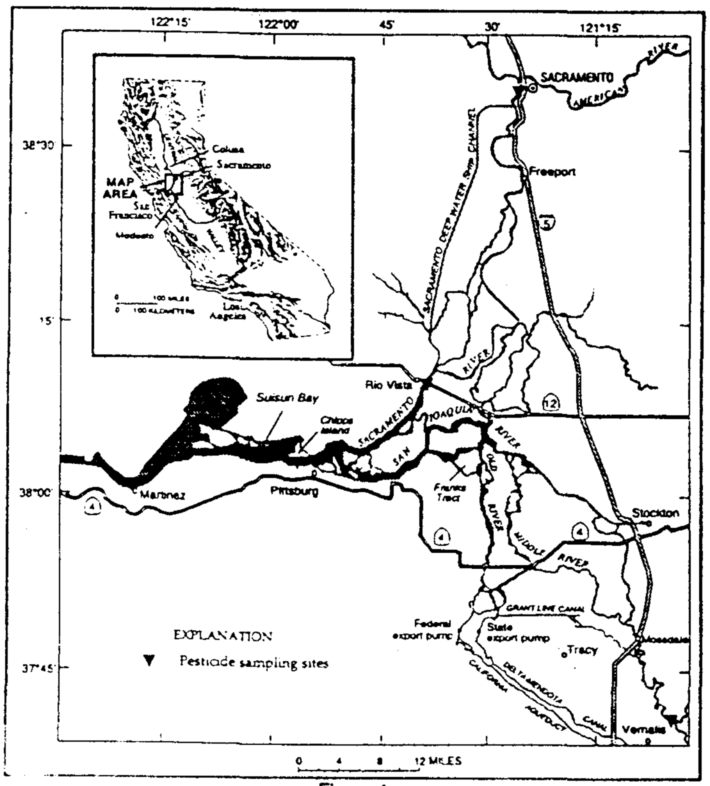


Figure 1
DIAZINON CONCENTRATIONS STUDY AREA

Riverine Diazinon Pulses

Diazinon was applied primarily at the end of January 1993, during 2 weeks of dry weather. After a series of rainstorms that began in early February, pulses of diazinon were observed in the Sacramento and San Joaquin rivers. The pulses were well defined, with elevated concentrations measured for a few days to weeks at a time. Figure 2 shows relationships among rainfall, daily mean discharge, and diazinon concentrations in the rivers.

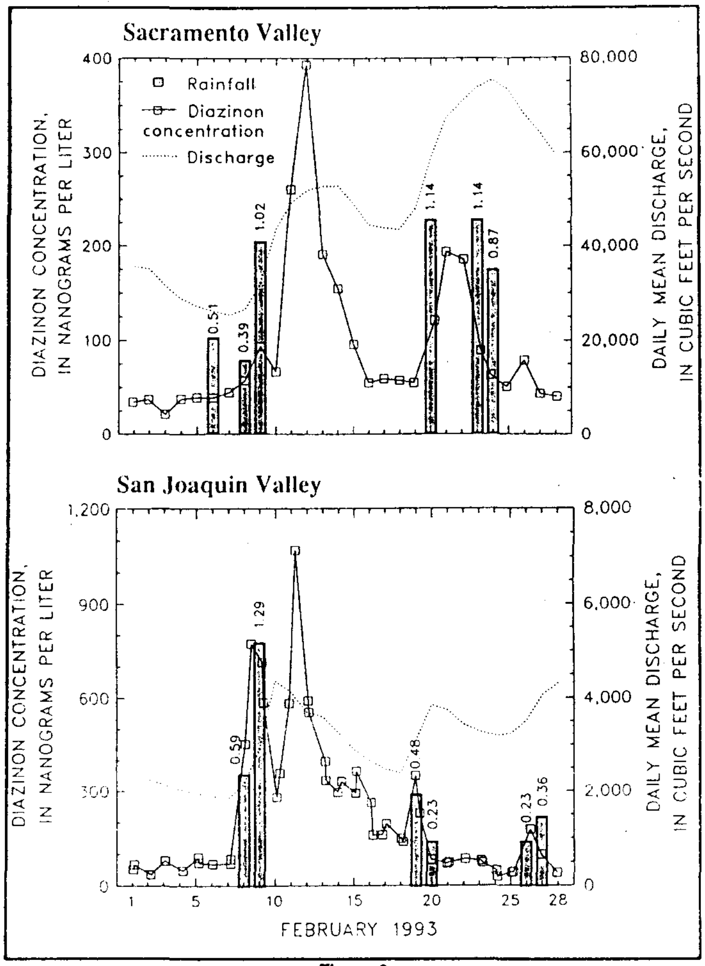


Figure 2
RAINFALL, DAILY MEAN DISCHARGE, AND DIAZINON CONCENTRATIONS IN THE SACRAMENTO AND SAN JOAQUIN VALLEYS

Rainfall shown as bar, with amount (in inches per day) above each bar.
Concentrations analyzed by solid-phase extraction and gas chromatography/ion trap detection.
Reporting limit for diazinon was 15 ng/L
Sacramento: rainfall at Colusa; tidally-filtered daily mean discharge at Freeport; diazinon at Sacramento.
San Joaquin: rainfall at Modesto; daily mean discharge and diazinon at Vernalis.

A few days after the rainfall (February 6, 8, 9), daily mean discharge of the Sacramento River at Freeport and diazinon concentrations at Sacramento began to increase (Figure 2, top) with diazinon concentrations reaching a maximum of 393 nanograms per liter on February 12. It rained again on February 20, and daily mean discharge and diazinon concentrations increased immediately. Diazinon concentrations peaked on February 21 at 194 ng/L and February 22 at 186 ng/L. After each rainfall, a pulse of diazinon moved past Sacramento with a time lag of 1 to 3 days between rainfall and maximum diazinon concentration.

In the San Joaquin River, daily mean discharge and diazinon concentrations at Vernalis began to increase immediately after the first rainfall on February 8 (Figure 2, bottom). Two well-defined peaks of diazinon concentrations were detected. The first maximum (773 ng/L) was at 2400 on February 8; the second (1,071 ng/L) was at 1900 hours on February 11. Two other rainfalls (February 19-20 and 26-27) also were followed the next day by a diazinon concentration maximum at Vernalis.

Diazinon Transport into San Francisco Bay

A major flow path of water down the Sacramento River is along the channel past Rio Vista, Chipps Island, and Martinez (Figure 1). The first pulse of diazinon in the Sacramento River was traced from Sacramento through Suisun Bay (Figures 1 and 3).

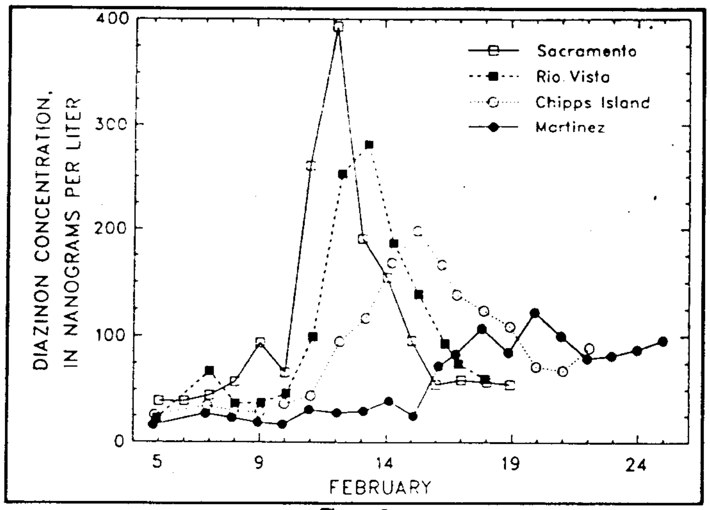


Figure 3
DIAZINON CONCENTRATIONS AT SACRAMENTO, RIO VISTA, CHIPPS ISLAND, AND MARTINEZ, FEBRUARY 1993

Samples were collected daily at slack after ebb tide. Ticks represent noon of indicated day.

Diazinon concentrations at Sacramento reached a maximum on February 12. On February 13, the pulse reached Rio Vista, 43 miles downstream from Sacramento, with a maximum concentration of 281 ng/L. Concentrations at Chipps Island, 16.5 miles seaward from Rio Vista, reached a maximum (199 ng/L) on February 15. The peak at Martinez, 14.5 miles seaward from Chipps Island, was on February 18 (107 ng/L) and February 20 (122 ng/L). As the pesticide pulse moved seaward, maximum concentration decreased and temporal distribution broadened over time, largely because of tidally-induced mixing of water containing the pesticide.

Diazinon Concentrations in the Delta

High diazinon concentrations similar to those at Vernalis on February 8, 11, and 19 also were measured at Stockton on February 10, 13, and 21) (data not shown). In the central delta, water from the Sacramento and San Joaquin rivers converges in a series of complex, tidally-influenced channels, and concentrations of diazinon were elevated in both rivers during this period. Well-defined pulses of diazinon were not observed at the Old and Middle river sites; instead, diazinon concentrations steadily increased from 35 to 149 ng/L throughout February (data not shown).

Potential Biological Effects in the Delta

All concentrations of diazinon measured in the rivers and bay throughout this study were higher than the 9 ng/L guideline recommended by the National Academy of Sciences (1973) for protection of aquatic life. Currently, there is no EPA aquatic-life criterion for diazinon.

Potential effects on the biology of the San Joaquin River were estimated on the basis of 7-day bioassays using the water flea *Ceriodaphnia dubia* and following EPA protocol (1989). *C. dubia* mortality was 100 percent in water samples (split of samples analyzed for pesticide concentrations) collected for 12 consecutive days from February 8 to 19 from the San Joaquin River at Vernalis (data not shown). The bioassay mortality corresponded with diazinon concentration ≥148 ng/L. Conversely, no toxicity was observed in water collected on February 5 and 7, before the peaks of diazinon concentration, or on February 20 to 25, after the peaks of diazinon concentration (values ≤84 ng/L). Other pesticides, including chlorpyrifos, methidathion, and carbaryl, were routinely detected in these water samples and may have contributed to the toxicity.

References

Foe, CG, and V Connor, 1991. *San Joaquin watershed bioassay results, 1988-1990*. Staff Report: Central Valley Regional Water Quality Control Board, Sacramento.

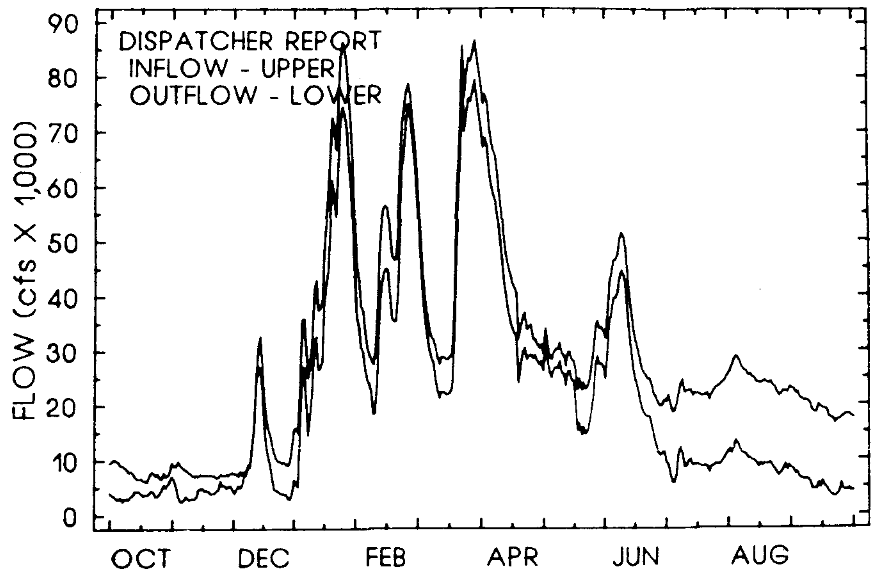
National Academy of Sciences and National Academy of Engineering, 1973 [1974]. *Water quality criteria, 1972*. U.S. Environmental Protection Agency, EPA R3-73-033.

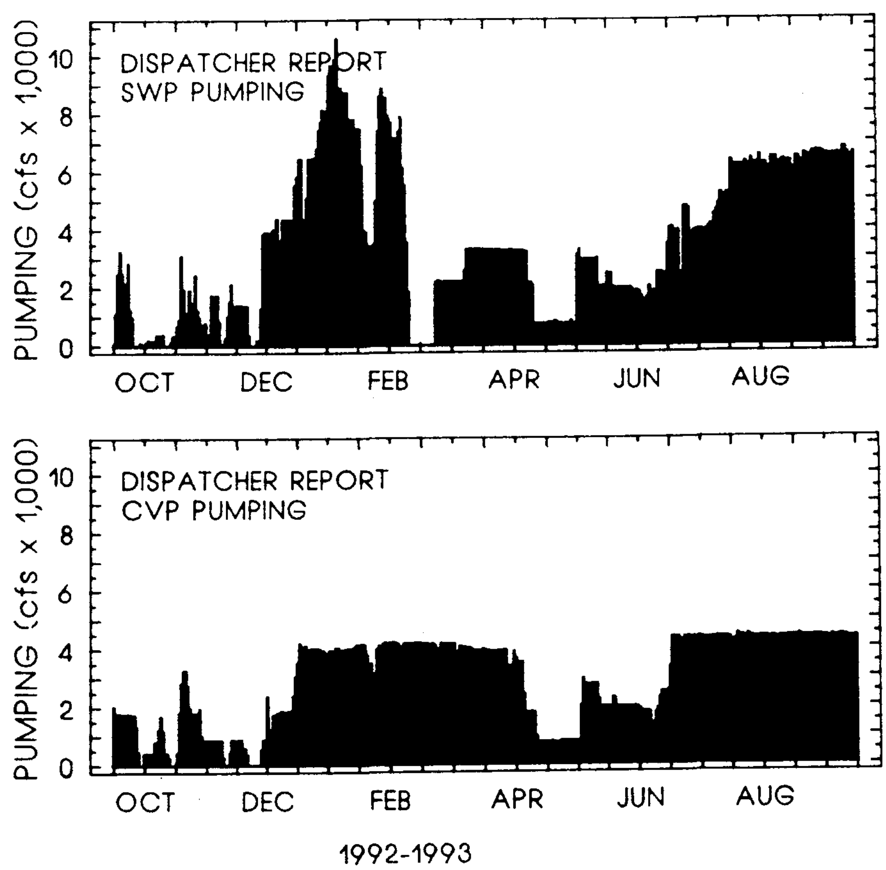
U.S. Environmental Protection Agency, 1989. *Short-term methods for estimating the chronic toxicity of effluents and receiving water to freshwater organisms* (2nd edition). Environmental Monitoring and Support Laboratory, EPA/600-4-89-001, Cincinnati.

Delta Flows

Sheila Green, DWR

These figures (right) illustrate delta inflow, delta outflow index, and project pumping for water year 1993. Delta inflow during July, August, and September 1993 averaged about 20,000 cubic feet per second, more than double that of 1992. Combined SWP/CVP pumping during August and September, at an average of about 10,000 cfs, was also high compared to 1992.





Directors Tour Estuary

Jim Arthur, USBR

On September 30, USBR sponsored a boat tour of the Bay/Delta estuary for some of the Interagency Program Directors and upper management. Participants toured portions of San Pablo and Suisun bays and visited the Montezuma Slough control structure. Stops along the way afforded an opportunity to discuss water quality and fishery issues affecting the individual agencies.

Participants included:

USBR, Mid-Pacific Region:
Roger Patterson, Regional Director
Dan Fults, Asst. Regional Director

State of California:
Doug Wheeler, Secretary for Resources
Dave Kennedy, Director, DWR
Al Petrovich, Deputy Director, DFG
John Amodio, BDOC

USFWS:
Wayne White, California Office
Gerry Jackson, Regional Office
Bill Shake, Regional Office

USBR staff conducting the tour included Jim Arthur, Doug Ball, and Ken Lentz.

Georgiana Slough Acoustical Barrier

Chuck Hanson, under contract to the San Luis and Delta-Mendota Water Authority, recently released a draft report describing results of last spring's testing of an acoustical barrier at the head of Georgiana Slough. Contact Chuck for a copy of the final report (510/942-3133).

Results of the testing were encouraging enough to warrant additional testing next spring. In addition, on October 1, the Authority filed an initial study and mitigated negative declaration on a January 1, 1994, barrier installation at Georgiana Slough. The objective of the early installation is to help prevent winter Chinook juveniles from entering the slough. Because of the small numbers of winter-run smolts, it will not be possible to directly evaluate the effectiveness of the barrier during this period. The evaluation period will be in April and May, when large numbers of outmigrants are passing the slough.

One concern expressed by fisheries agencies about an early installation involves possible blockage of upstream-migrating adults. Mitigation measures intended to alleviate this concern involve physically configuring the speaker array to minimize blockage of fish entering the Sacramento River from Georgiana Slough and to cycle the system so there will be periods when there is no sound generation. The initial study was widely distributed, and comments are due by November 9.

DWR is considering the possibility of installing an acoustical barrier at the head of Old River next spring to protect fall-run outmigrants from the San Joaquin system. If effective, an acoustical barrier could avoid some of the problems associated with a physical barrier, such as potential erosion at high flows and changes in internal delta flow patterns caused by the barrier. At this time, the only step toward installing this barrier is to have two firms that manufacture the systems, Sonalysts and EESCO, visit the site and ask them to provide cost estimates. The Old River site is not easy to screen with acoustical technology, and site-specific problems, along with costs and environmental concerns, will influence the decision on whether to proceed.

GIS Workshop

Jim Arthur, USBR

USBR will be holding a Geographic Information System workshop on November 5 to demonstrate capabilities of the system in analyzing and displaying data. Continuous monitoring equipment for vertical and spatial profiles installed on the sampling boats will collect a wealth of data, and we need a way to provide the information in an easily understood format. The workshop is geared toward those with little or no background using the GIS software. It will include an overview of the system, a discussion of how the system handles the various layers of data to create maps and graphics, and several demonstrations of the system's data presentation capabilities. Some of the demonstrations will use Interagency Program data collected by DWR, DFG, and USBR.

The workshop is limited to 30 Interagency Program managers. Call Sheryl Baughman or Dave Sullivan for more information (916/978-4923).

Available through Aquatic Habitat Institute ...

Teaching About Creeks — Held at Mills College, Oakland
Workshops on November 6 ($30)
Field Trips on November 7, November 13, November 14 ($20 each)

These workshops and field trips are presented by the Aquatic Habitat Institute, Contra Costa County Association of Science and Math Educators, Marin County Office of Education, and Mills College. Professional credit for the fall semester is offered through Mills College. Both the workshops and field trips are expected to sell out, so register early and avoid disappointment. For information or a registration form, call AHI (510/231-9539).

Exploring the Estuary — Macintosh-based educational display on San Francisco Bay and the Delta ($30 to $95, depending on whom you represent)

Available in 9-inch and 15-inch display versions. The display contains information about resources in and human impacts on the bay and delta. The 15-inch version also includes information on the Gulf of the Farallones National Marine Sanctuary. Both versions feature many sounds, including 13 bird sounds. The program was developed by Aquatic Habitat Institute and the National Oceanic and Atmospheric Administration, with assistance from the Oakland Museum and the Lawrence Hall of Science, and with partial funding provided by the San Francisco Estuary Project. Equipment requirements are a MacPlus or above; running System 6.0.5 or above; 2 MB RAM; hard disk with 5 MB free space. Full page version requires a full page display. For information or to place an order, call Michael May, AHI (510/231-9539).